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The distribution of salinity in the waters of Long Island Sound, Block Island Sound, and Newport Bight. Cruise STIRNI - III, January - February 1952.

by

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The data presented in this report were obtained during January and February 1952 on Cruise STIRNI - III of this project. Figure 2 indicates the locations of the stations at which the data were obtained, as well as the locations of the vertical sections presented in Figures 3 through 6.

A break in the sequence of observations in Newport Bight occurred on February 7th when one of the ship's engines broke down. Work was resumed on February 16. Since the heaviest storms and most turbulent sea conditions of the cruise period had occurred prior to this break, it is considered that reasonably little error is introduced by treating the data synoptically.

The four westernmost stations of the cruise were occupied twice, at slack before flood and at slack before ebb, to determine the displacement of isohalines by the tide in the narrow western part of Long Island Sound. All the remaining stations were taken without regard to tidal time. In Figure 1 the surface contours of salinity at slack before flood are drawn continuous with the tideless area of Long Island Sound and slack before ebb is shown as an inset in the corner of the chart.

Values of surface salinity presented in Figure 1 are the combined STD and station values. Only the salient features of the salinity distribution will be described for the figures present detailed pictures of the conditions encountered. If complete numerical data are desired they may be obtained from "Data Report No. 2" of this Project.

OBSERVATIONS

The surface salinity increased from the Upper East River to eastward. A low of 23.5 o/oo was observed in the Upper East River at slack before ebb; the maximum salinity observed was 33.0 o/oo in a small area 15 miles southeast of Block Island. The salinity at the extreme western end of Long Island Sound was less at slack before ebb (23.5 o/oo) than at slack before flood (25.0 o/oo). This is due to freshened water from New York Harbor and the Hudson River which enters the Sound during late flood (Harmer 1935, Ayers 1951). The distribution of surface salinity was characterised by a tendency of freshened water to occur along both the north and south shores of Long Island Sound and for relatively more saline water to extend westward in the north central part of the Sound. Block Island Sound showed a tendency for water along the southern shore to be somewhat fresher than that along the north shore.

The vertical distribution of salinity showed the water to be nearly homogeneous from surface to bottom in all parts of the Sounds and in Newport Bight. In Newport Bight (Figure 3) the salinity at the time of the cruise was 32.0 - 33.0 o/oo.

In Block Island Sound (Figure 4) water of 32.0 - 32.5 o/oo occupied most of section G-G' from Block Island to Point Judith and similar water filled the central and eastern parts of section H-H' (from Montauk Point to Block Island); freshened water of <31.5 - 32.0 o/oo occurred at Montauk Point. Section J-J' through Fishers Island Sound, The Race, and western Block Island Sound, contained surface water of <30 o/oo in The Race, and in Fisher Island Sound while slightly more saline water filled the southern part. In this section water of 30.0 to >30.5 o/oo lay beneath the freshened surface waters. In section K-K which crossed eastern Long Island Sound, Plum Gut and Gardiners Bay, water of more than 30.0 o/oo was found at depths of 7 to 18 fathoms in the north end of the sections

the central and southern parts of the section contained freshened water of 28.5 - 29.0 o/oo. In section K-JJ E-AA waters of < 30.0 o/oo lay north and west of Montauk Point and water of < 31.6 o/oo lay at the eastern tip of Montauk Point.

In Figure 5 sections L-L' and M-M' both contained water of > 30.0 o/oo which was confined to the north half of the section, and fresher water of 28.0 o/oo in the south half. In both these sections there was a small area of freshened water at the extreme north end of the section. Similarly in sections N'-N, O'-O, and P'-P the north end of the section contained water of < 26.5 o/oo; In these sections the south ends also contained freshened water, while the central areas were occupied by water of > 27.0 to > 26.5 o/oo. In section Q'-Q water of greater than 26.0 o/oo occupied the bottom of the north half at both slack waters. At slack before flood the south half of the section was filled by < 26.0 o/oo water, while at slack before ebb water of this salinity extended over the surface of the whole section.

Longitudinal sections of the survey area show the same picture as do the transverse sections. Sections L-L' and D-D' along the north and south shores respectively, show the two essentially the same salinity distribution pattern except that the southern section, D-D', is for any given north-south line consistently 0.5 o/oo or more fresher than L-L'. Along the north shore pronounced lenses of much-freshened water lay close to the river mouths; they apparently were the runoff of the Connecticut rivers; no such lenses occurred along the Long Island shore. In Long Island Sound water of 26.0 - 28.0 o/oo extended noticably further to the west in mid-Sound, section F-A, than in either the north or the south section. In Block Island Sound the 29.0 - 32.0 o/oo isohalines extended somewhat further to westward along the north shore and in mid-Sound than they did along

Island Sounds is quite consistent with the over-all pattern of surface currents shown by Riley (1952, Figure 10). There is a definite tendency for more saline water to extend further westward in the north half of the Sounds and for freshened water to extend [illegible] half of the Sounds. Similar patterns have been [illegible] (Ayers, Ketchum, and Redfield 1948, Bason and Miotsch 1949, Ford 1949); in each case the more saline water extended landward along that shore which was to the right of the flood current and the seaward extension of freshened water was along that shore to the right of the ebb current. Such a pattern is the effect of Coriolis force. Long Island Sound shows a modification of this characteristic pattern in that local dilution by runoff freshens a band of water along the northern shore.

In the wide central part of the Sound there is indication that water of 27.5 o/oo and 28.0 o/oo is carried in a counterclockwise direction; this is the location where Riley indicated a counterclockwise eddy. To the east of this area, between 72°20' and 72°40' W and in the vicinity of Long Sand Shoal, Riley (loc. cit.) described a clockwise eddy; an area of 28.5 o/oo water occupies this region and if it is an eddy undoubtedly rotates clockwise.

The large lens of much freshened water at the mouth of the Connecticut River is not necessarily a permanent feature of the salinity distribution for the [illegible] crosses this area during the middle of the ebb tide.

The major part of Block Island Sound was occupied by water of < 31.5 o/oo. In western Block Island Sound diluted waters extended from The Race to Montauk Point. These are the Long Island Sound outflow which in winter is reduced in amount by the frozen conditions in the mainland watersheds.

Riley (1952) has reported inward flow of salt water in the bottom waters of The Race and along the bottom into Long Island Sound; the data of this cruise are entirely compatible with this conclusion (see sections J-J', and KK-K). In these sections bottom water of 30.0 o/oo and more extends through The Race and into eastern Long Island Sound. Between sections KK-K and L-L' mixing has apparently occurred, for the most saline bottom water in the latter section is >28.5 o/oo. The same water, though less in amount is present in section M-M'. Between sections M-M' and N'-N further mixing apparently takes place, for the most saline of the bottom waters in sections N'-N, O'-O, and P'-P is 27.0 o/oo. Between P'-P and Q'-Q still further admixture of fresh water must occur for the bottom water of section Q'-Q is of salinity 26.0 o/oo.

It must be noted at this point that the present survey was conducted in winter, and that some estuaries change over from a vertical stratification (in spring and summer) to a lateral stratification in late fall and winter. In the latter season the net landward drift of more saline water is no longer subsurface, but becomes a vertically homogeneous water mass reaching from surface to bottom and situated along that shore which is on the flood current's right. Conversely the exodus of freshened waters through such an estuary takes place in vertically homogeneous water of lower salinity also reaching from surface to bottom but situated along that shore which is on the right of the ebb current. Raritan Bay is an estuary in which change of stratification of this sort has been observed (Ayers, Ketchum, and Redfield 1948); the present data suggest that in winter Long Island Sound west of 72°40' W exhibits this type of lateral stratification, but with one degree of complication ---- the presence of the alongshore band of locally-freshened water on its north shore.

The horizontal distributions of salinity in Long Island Sound and Block Island Sound observed in January - February 1952 are in good agreement with the composite diagram of surface currents published by Riley (1952).

The observed distribution of surface salinity is in agreement with the previously observed net outflow of water from the Upper East River into Long Island Sound (Ayers 1951). It is also in agreement with the hypothesis that Long Island Sound west of 72°40' W is occupied by a large counterclockwise eddy, east of which (to 72°20' W) a clockwise eddy is situated in the north and central parts of the Sound.

The distribution of surface salinity during this cruise is further in agreement with Riley (1952) in that it indicates a seaward escapement of freshened water along the south shore of the Sound, through The Race, and close around Montauk Point in a southwest direction. The latter was also observed during Cruise STIRAI - I (Status Report No. 10).

From the present data and from unpublished data obtained by this contract in Long Island Sound in mid-summer (when moderate thermal stratification and weak salinity stratification were found) it appears that central and western Long Island Sound exhibit a bi-seasonal change of location of the saline landward drift which brings salt water into the Sound. In fall and winter this drift takes the form of vertically homogeneous water arranged in a broad belt in the north central part of the Sound; in spring and summer it is on the bottom and beneath fresher water. During summer it is probable that the landward drift is continuous along the bottom from Block Island Sound to western Long Island Sound.

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Legend

Figure 1. Surface Salinity, o/oo, in Long Island Sound, Block Island Sound, and Newport Light, Cruise STIMMI - III, January - February, 1952.

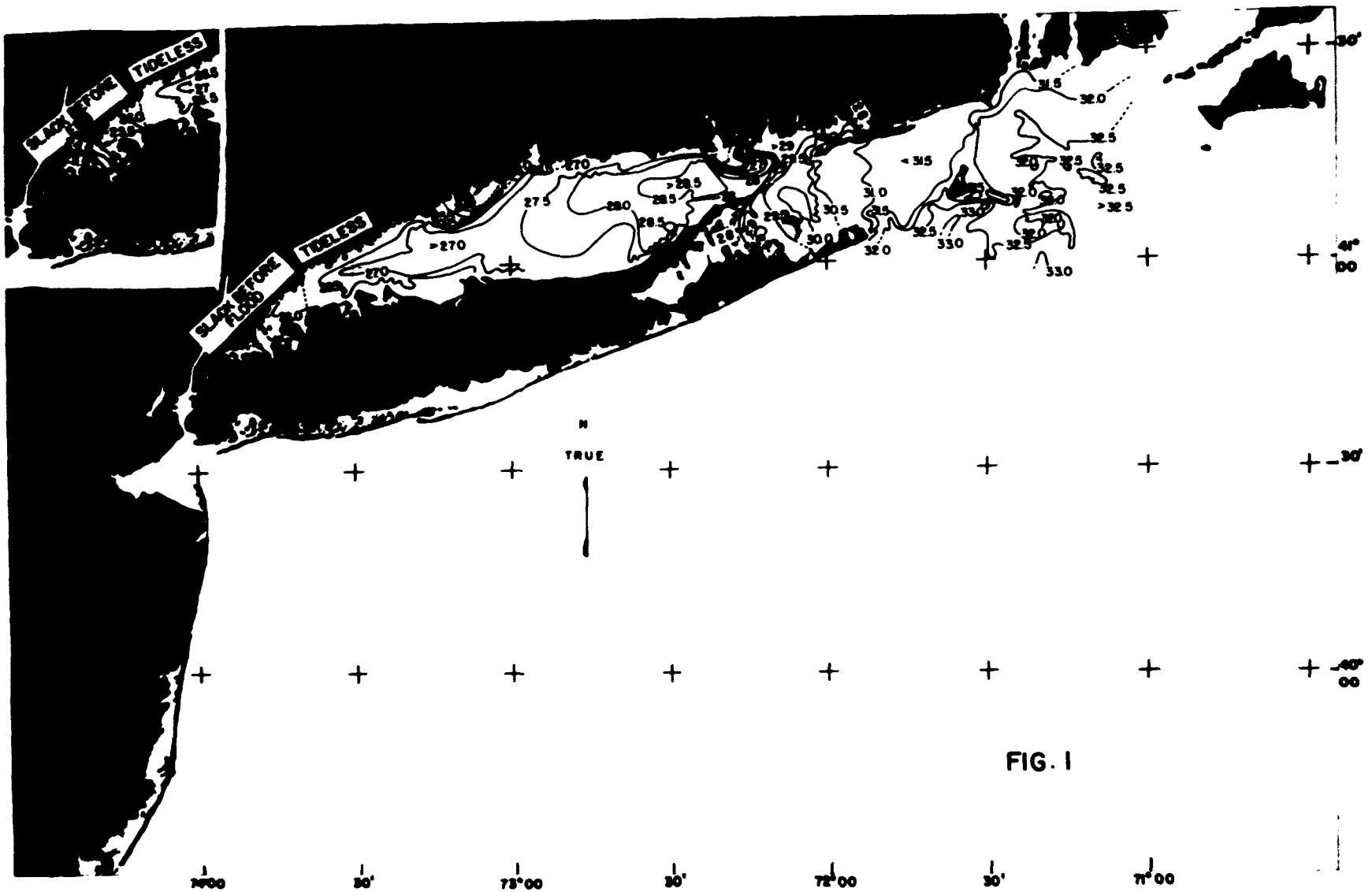
SLACK BEFORE FLOOD
TIDELESS
SLACK BEFORE FLOOD
TIDELESS
N
TRUE
40° 00
30'
74°00
30'
73°00
30'
72°00
30'
71°00

FIG. 1

Legend

Figure 2. Location of stations and Vertical Sections in Long Island Sound, and Newport Light, Cruise STIPPI - III, January - February, 1952.

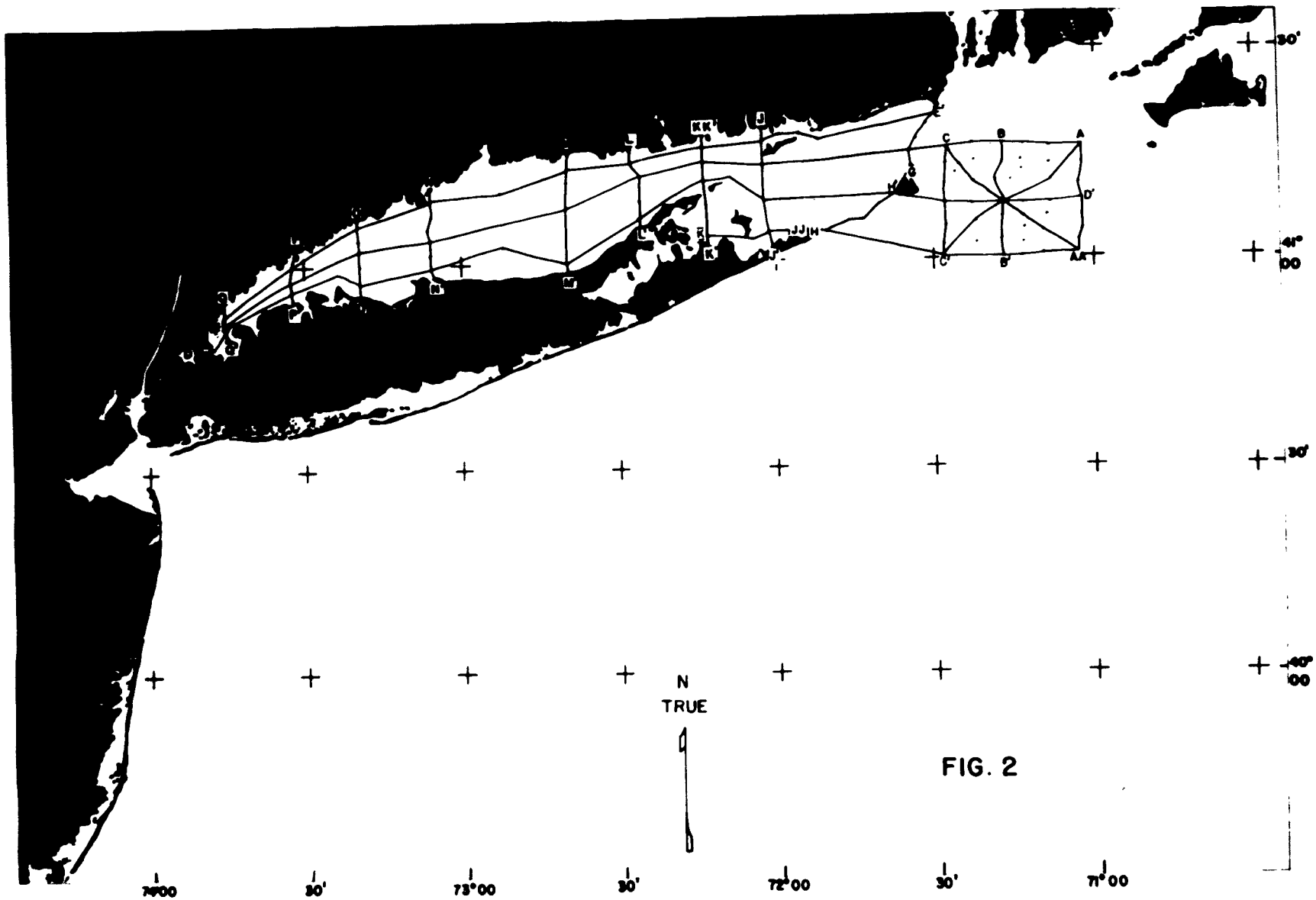

FIG. 2

Legend

Figure 3. Vertical Distribution of Salinity, o/oo, in Newport Bight, Cruise STIRMI - III, January - February, 1962.

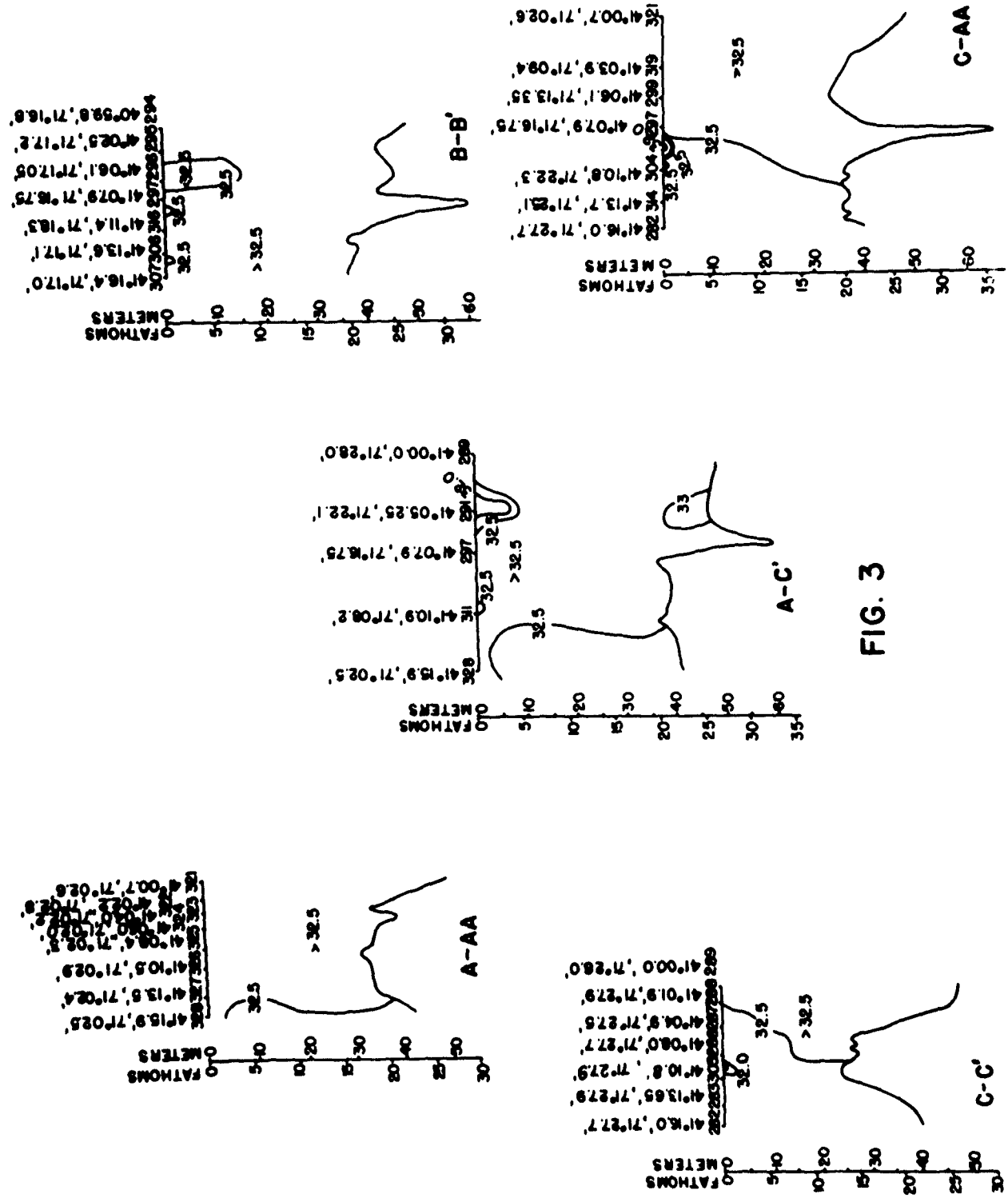

FIG. 3

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Figure 4. Vertical Distribution of Salinity, o/oo, in Block Island Sound, Cruise STIP.I - II, January - February 1952.

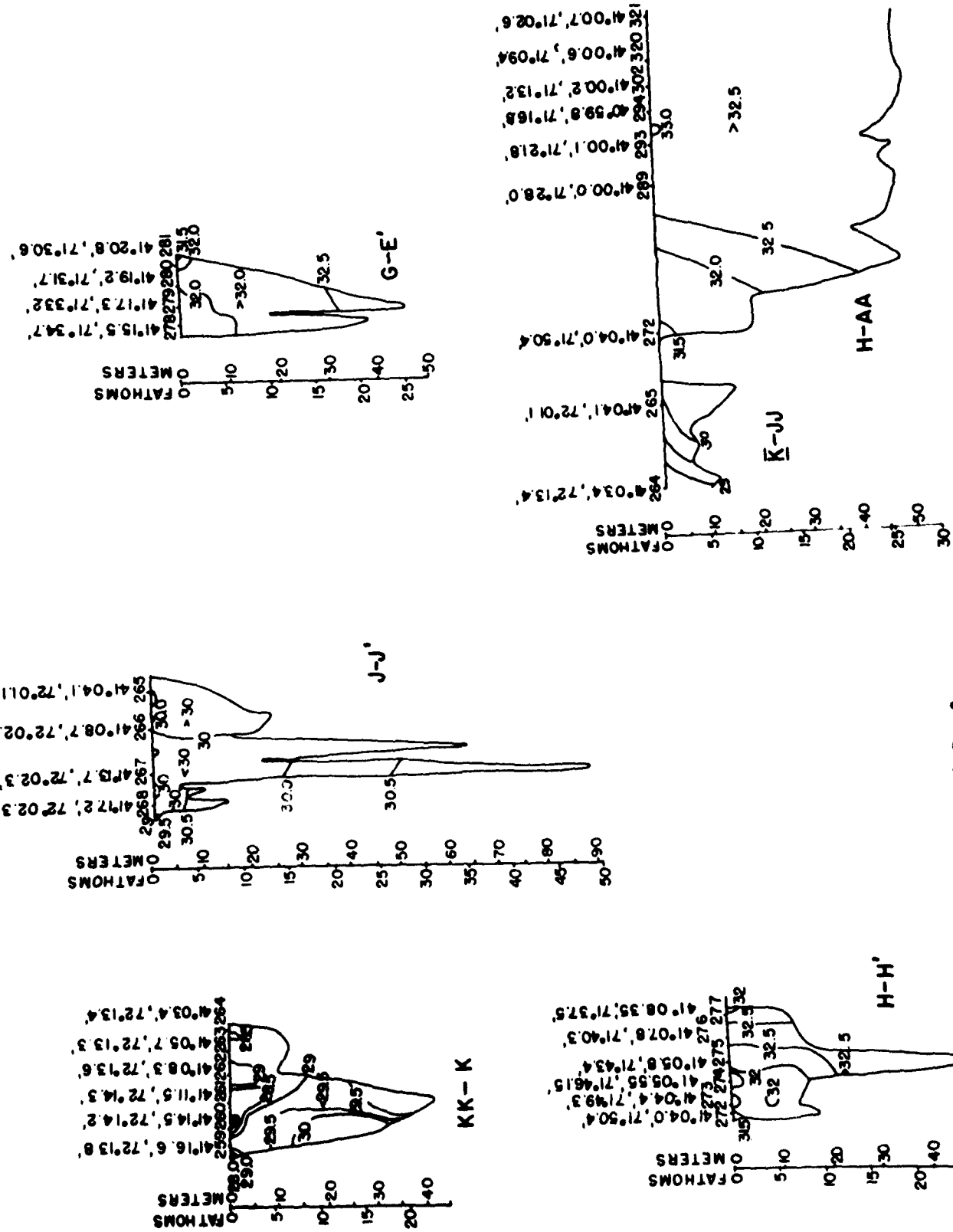

FIG. 4

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Figure 5. Vertical Distribution of Salinity, o/oo, in Long Island Sound, Cruise STIR I - III, January - February.

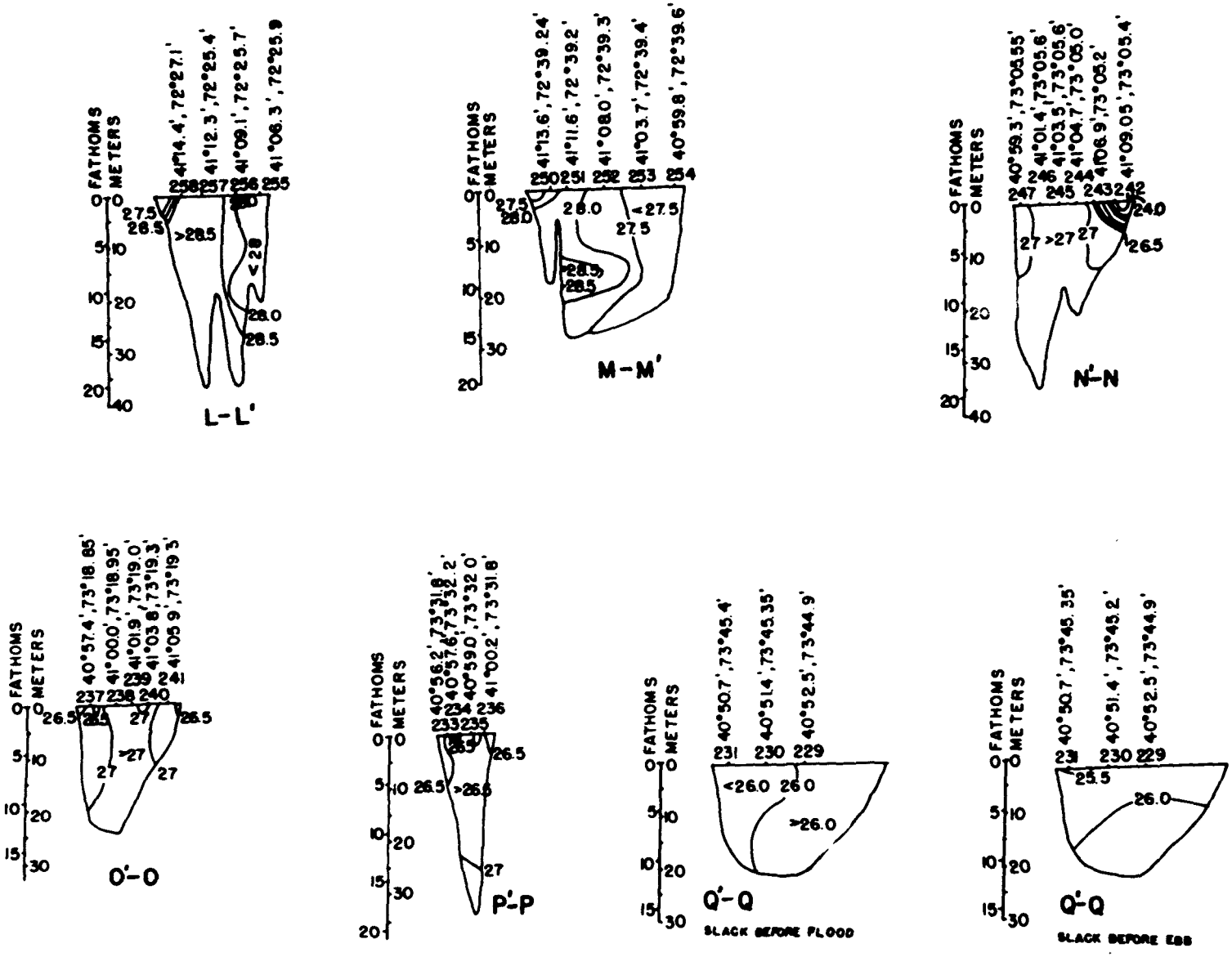
FATHOMS
METERS
41°14.4', 72°27.1'
41°12.3', 72°25.4'
41°09.1', 72°25.7'
41°06.3', 72°25.9
258 257 256 255
27.5
26.5
>28.5
<28
28.0
28.5
L-L'
41°13.6', 72°39.24'
41°11.6', 72°39.2'
41°08.0', 72°39.3'
41°03.7', 72°39.4'
40°59.8', 72°39.6'
250 251 252 253 254
27.5
28.0
28.0
<27.5
27.5
28.5
28.5
M-M'
40°59.3', 73°05.55'
41°01.4', 73°05.6'
41°03.5', 73°05.6'
41°04.7', 73°05.0'
41°06.9', 73°05.2'
41°09.05', 73°05.4'
247 246 245 244 243 242
24.0
27
>27
27
26.5
N'-N
40°57.4', 73°18.85'
41°00.0', 73°18.95'
41°01.9', 73°19.0'
41°03.8', 73°19.3'
41°05.9', 73°19.3'
237 238 239 240
26.5
27
>27
27
27
26.5
O'-O
40°56.2', 73°31.8'
40°57.6', 73°32.2'
40°59.0', 73°32.0'
41°00.2', 73°31.8'
233 234 235 236
26.5
26.5
>26.5
27
P'-P
40°50.7', 73°45.4'
40°51.4', 73°45.35'
40°52.5', 73°44.9'
231 230 229
<26.0
26.0
>26.0
Q'-Q
SLACK BEFORE FLOOD
40°50.7', 73°45.35'
40°51.4', 73°45.2'
40°52.5', 73°44.9'
231 230 229
25.5
26.0
Q'-Q
SLACK BEFORE EBB

FIG. 5

Legend

Figure 6. Vertical Distribution of Salinity, o/oo; Profiles Constructed From West to East Across Entire Area Covered by Cruise STIMI - III, January - February, 1952.

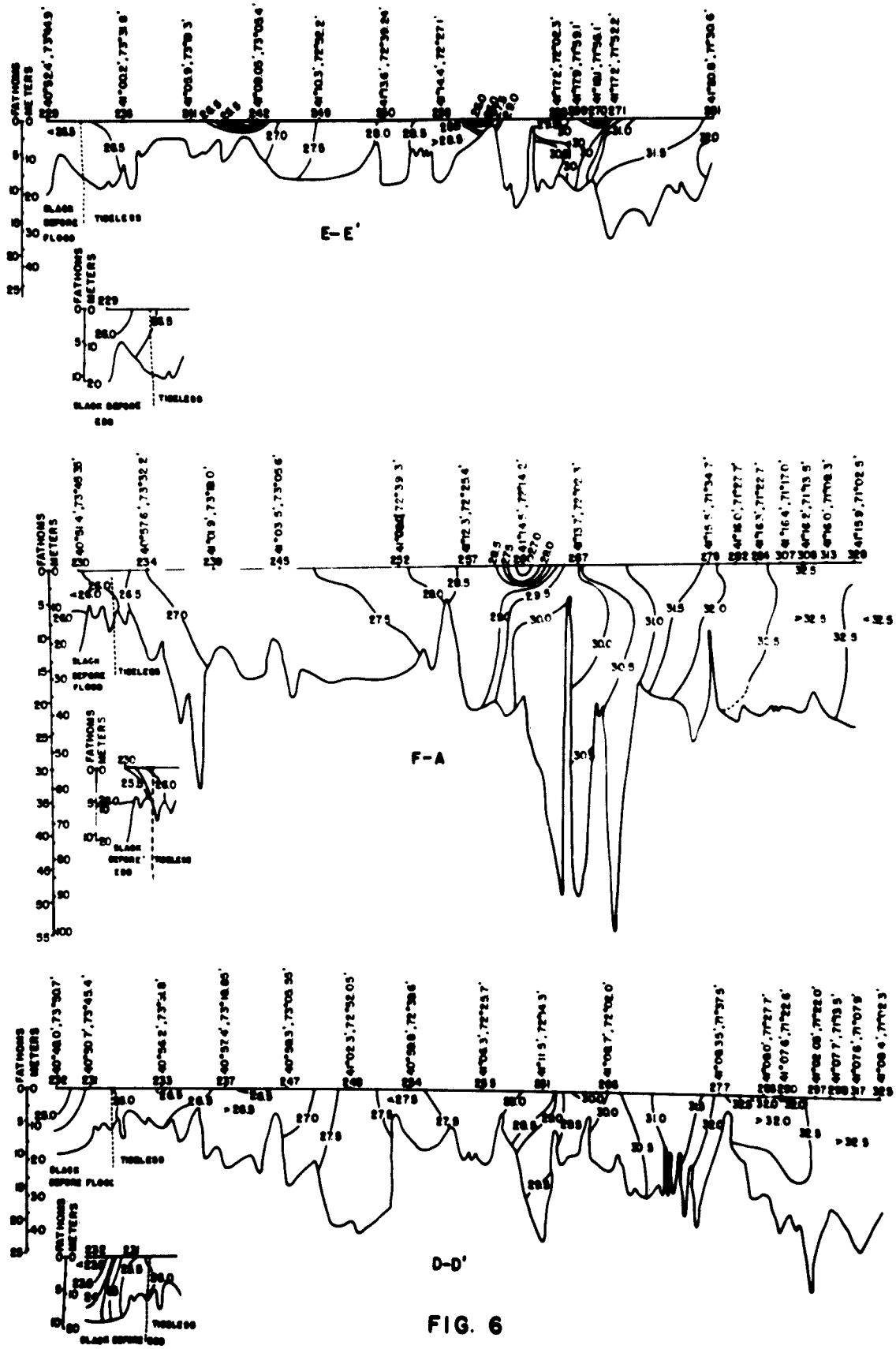

FIG. 6

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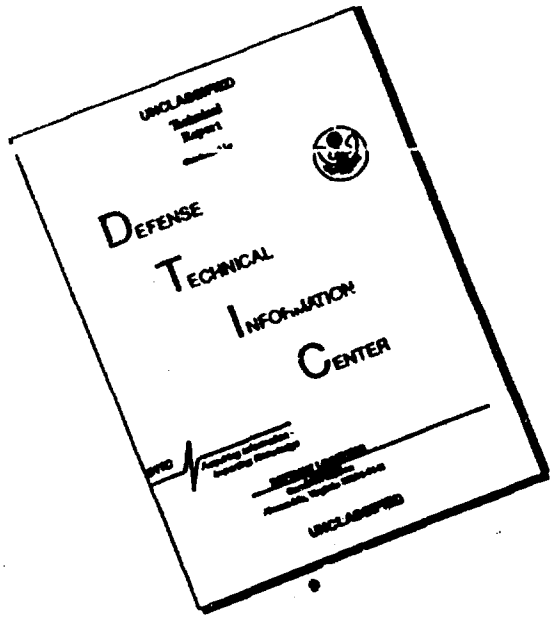

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